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SPACE CENTER Roundup

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Season's Greetings

As the holiday season approaches, we can all take pride in the Center's progress this year, setting the stage for what promises to be a productive and challenging year in 2000. While we flew fewer space flights than anticipated, this year was one of accomplishment: a very successful logistics flight to Zarya and Unity, the deployment of an outstanding X-Ray Observatory, and we will soon proceed to restore the capabilities to a unique and history-making astronomical observatory, the Hubble Space Telescope.

This year was not without its problems. They reminded us of the need to pay attention to detail. The shuttle is indeed a wonderful spacecraft, but one that requires our attention and tender loving care. Our emphasis on wiring during these past few months will make the shuttle a much more dependable and effective vehicle for future missions. The increased emphasis on safety from the Administrator down to the worker on the floor has also brought a greater recognition of the need for shuttle upgrades and an investment in this critical activity on the part of the Congress. These upgrades will make the space shuttle an even more reliable and safer vehicle that will fly well into the next century. On the ground, our focus on safety continues to be of paramount importance. From an outstanding Safety and Total Health Day, to JSC's recognition as a Voluntary Protection Program Star site, your attention to quality and safety is commendable.

Many of you have been involved in critically important advanced technology efforts. These have ranged from advances in materials such as carbon nanotubes, to medical breakthroughs including a promising new drug delivery system, to advances in spacesuit and life support system design for future human space exploration, to advances in spacecraft design and testing including the X-38 and the TransHab. If we are to set the stage for an eventual return to the moon and for the human exploration of Mars, these great strides in research and development must continue.

Our research efforts in the physical and life sciences at JSC have also been impressive this year. A team of JSC scientists reported finding liquid water in a meteorite, the first discovery of its kind and a potential indication that life may exist outside our planet. And the National Space Biomedical Research Institute investigators continue to pursue and evaluate techniques to control the physiological problems associated with long-duration space flight.

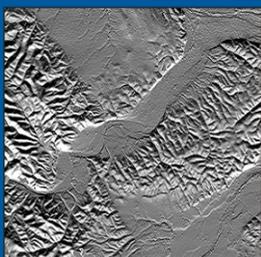
The White Sands Test Facility continues to demonstrate world-class expertise with an outstanding year of performance, providing a wide variety of test and laboratory research and development support to all NASA centers, the Department of Defense, other government agencies and private industry.

The efforts of individuals working abroad – and in Russia, in particular – have contributed greatly to our successes in 1999. I would like to extend my best wishes to all those individuals and their families for helping to make a difference.

Equally important, we have continued to share our story with more and more people through venues such as Open House and Inspection99, as well as through a variety of education programs. From student co-op programs and KC-135 outreach efforts to tutoring in local schools and collaborating with local and regional efforts to improve education, we could not have accomplished outreach of this magnitude without your unwavering volunteer efforts – and for that, I thank you.

As part of the nation's space program, we are faced with challenges from every direction. With your passion and commitment to fulfilling the nation's goals, however, we can continue to build on the legacy and legend of NASA. Our experience during past years demonstrates we can overcome the obstacles ahead of us. I thank all of you – the civil servant/contractor workforce team and our supporters in the community – for your hard work and your outstanding contributions to furthering the exploration of space. My heartfelt wishes to you and your families for a joyous holiday season. ■

George W. S. Abbey



STS-99 to demonstrate new 3-D mapping.

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Preparing for extended space flight.

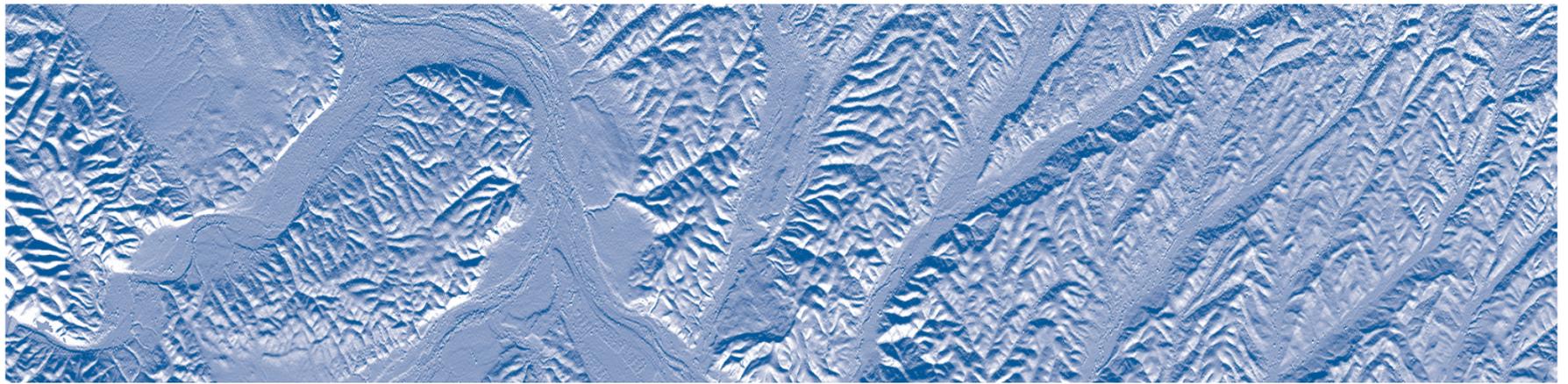
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JSC employees share the spirit of giving.

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STS-99 to demonstrate new mapping technology



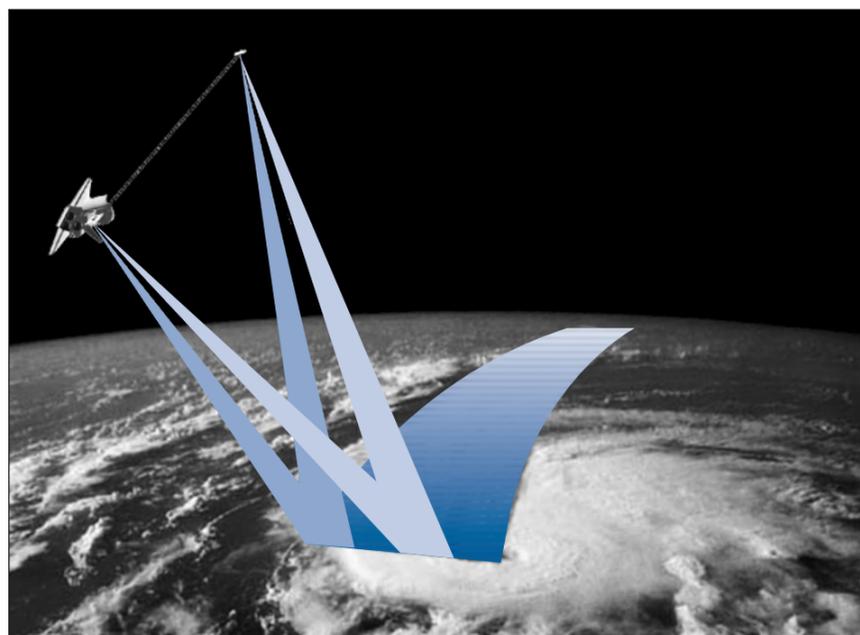
This image shows a region of central California centered at Camp Roberts, near Parkfield, CA, a region of great interest to seismologists because of its frequent earthquake activity. The area is a site of intensive topographic mapping that will be used by the Shuttle Radar Topography Mission project to compare its data against other topographic data sets. The terrain consists of rolling grassy hills and groves of heritage oaks. The river valleys to the left in the image are formed from the confluence of the Salinas, San Antonio and Nacimiento rivers.

Flying backward around the globe with two antennae and a 200-foot-long section of space station mast protruding from its payload bay, the Space Shuttle *Endeavour* and crew will attempt to produce unrivaled 3-D images of the Earth's surface in January.

The result could be close to 1 trillion measurements of the Earth's topography. Besides contributing to the production of better maps, these measurements could lead to improved water drainage modeling, more realistic flight simulators, better locations for cell phone towers, and enhanced navigation safety.

Just about any project that requires accurate knowledge of the shape and height of the land can benefit from the data. Some examples are flood control, soil conservation, reforestation, volcano monitoring, earthquake research, and glacier movement monitoring. The measurements, which once processed are expected to be accurate to within 50 feet, may be tailored to meet the needs of the military, civil, and scientific user communities.

Creating these 3-D images of the Earth's surface on STS-99, known as the Shuttle Radar Topography Mission, will require the first on-orbit use of a technique called single-pass radar interferometry. Two radar images will be bounced off the surface simultaneously – one by the same C-band and X-band radar antennas used to



take radar images from the shuttle's payload bay on STS-59 and STS-68, and another similar antenna at the end of the 60-meter mast extending perpendicular from the payload bay.

Building and deploying the mast, which is two-thirds as long as the International Space Station will be when complete, will be a significant accomplishment in itself. Extending the longest rigid structure ever

flown in space – stored accordion-style inside a canister attached to the side of the main antenna – will require the first use of a new shuttle piloting technique called the "flycast maneuver." The maneuver, practiced on STS-93, will help reduce structural loads on the mast.

The power needed to operate the radar antennae and associated equipment pushes the edge of the shuttle's generat-

ing capability for the 11-day flight. A total of 900 Kilowatt-hours (enough to power a typical home for 2-3 months) will be needed.

All data will be recorded on board the shuttle using Payload High Rate Recorders – enough to fill 15,000 CDs. Small slices of data will be downlinked to Earth for developers from NASA's Jet Propulsion Laboratory to study during the flight, but they can be downlinked at only a quarter of the speed they are recorded.

Endeavour will be launched in an orbit with an inclination of 57 degrees to allow the entire land surface that lies between 60 degrees north and 56 degrees south latitude to be covered, which includes the majority of the Earth's populated surface area.

Commander Kevin Kregel will lead the mission, making his fourth flight. Dominic Gorie will serve as pilot, making his second flight. Mission Specialists Janet Kavandi (second flight), Mamoru Mohri of the National Space Development Agency of Japan (second flight), and Gerhard Thiele of the European Space Agency (first flight) round out the crew.

Intercenter, interagency and international cooperation are hallmarks of the mission. It is a joint project of NASA, the Defense Department's National Imagery and Mapping Agency, the German Aerospace Center, and the Italian Space Agency. ■

JSC to sponsor second annual Mars Settlement Design Competition

Building on the success of the February 1999 initial JSC Mars Settlement Design Competition, JSC will sponsor the event for a second year February 11 - 13, 2000.

The second annual Mars Settlement Design Competition will bring high school students to JSC for an intensive overnight weekend program in which they will compete in the design of a future human Mars base. "We are looking forward to another stellar educational experience for the students," says this year's chair, Nancy Robertson, chief of the Education and

Community Support Branch of the Public Affairs Office.

Students with a variety of skills will be teamed with others to form four competing student companies. Up to 120 students will be able to take part in the competition. Students need not be science and technology focused to enjoy the competition. It takes a wide variety of people, talents and skills to prepare a design and proposal for a project this large. Analysts, planners, artists, writers, organizers, managers, communicators, and others with imagination and creativity will be needed by each student company.

Each company will be provided with a professional NASA or industry manager to serve as CEO and to guide the students in their processes. The students will receive all the training, guidance and information needed to prepare a winning design and proposal as part of the competition activities. The competition concludes with each student company's presentation of its proposal to a panel of NASA and industry judges, who select the winning proposal.

Students who participate in this competition will learn much about Mars, space science, the space environment, engineering

and business careers, organizing, integration of complex activities, teamwork, management, and effective communications, all set in an exciting and unusual context.

The competition is being held as part of JSC's National Engineers Week activities.

If you have family members or friends who are high school students and who would be interested in participating in this competition, you may contact Norman Chaffee, competition coordinator, AP2, at (281) 483-3777 for more information and an application form. ■

Volunteers needed for Engineers Week 2000

JSC is proudly participating for a 9th consecutive year in National Engineers Week and needs your participation to make this popular educational outreach program a continued success. With the volunteer participation of some 175 JSC civil service employees and the contractor community, more than 18,000 area students and teachers had space-related classroom presentations during the 1999 National Engineers Week program.

National Engineers Week is an annual event to help raise public awareness and appreciation of engineers and their work.

More than three million engineers, teachers, and students will participate nationwide. As part of the Discover "E" ("E" for Engineering) program, JSC civil service and contractor engineers and other employees will visit classrooms to show students how math, science, and engineering create the world around them and to introduce them to technical careers. With declining enrollment figures in the engineering fields, National Engineers Week offers a great opportunity for each of us to contribute to our community's technical education efforts.

Volunteers are asked to commit to giving classroom presentations to students that attend grades K-12 in schools within 50 miles of JSC anytime during the month of February. For civil service employees, time spent participating as a National Engineers Week volunteer may be charged to the education labor code. Contractor employees need to check with their individual supervisor, human resource or payroll offices for instructions on how to charge National Engineers Week volunteer time.

JSC's Education Outreach Program will host Volunteer Training Sessions

January 25-28, 2000, from 10-11 a.m. daily, in Bldg. 17 Rm. 242, that will include a panel of veteran volunteers and former teachers who will discuss presentation tips and demonstrate hands-on activities for use in the classroom. Also, access to resources such as exhibits, videos, and promotional materials will be discussed.

Individuals interested may sign up and select classroom assignments online by visiting JSC's National Engineers Week Web site at <http://www4.jsc.nasa.gov/scripts/eweek/> ■

PEOPLE IN THE NEWS**Johnson receives Minority Business Advocate Award**

Photo by Grady Carter

Debra Johnson, NASA JSC's deputy director of procurement, received the Minority Business Advocate Award at the Minority Enterprise Development Week awards ceremony and 8th annual Greater Houston Business Procurement Forum Awards Breakfast held October 19. Johnson serves as JSC's senior advisor on small business.

The Small Business Administration's Houston District Director Milton Wilson presented Johnson a bronze statue of an American eagle honoring her for support to the SBA and outstanding contributions to many small and minority-owned businesses and organizations that advocate for small business. The JSC Small Business Program, steered by Johnson, has frequently received recognition from area and national organizations.

MED Week was designated by Presidential Proclamation in 1983. This year's event provided minority business owners, corporate and government executives, purchasing representatives and other minority business advocates a forum to network, develop strong business links and address issues. MED Week activities were scheduled the entire week and included public and private sector companies and the greater Houston small business community.

The U.S. SBA-Houston District, the U.S. Department of Commerce Minority Business Development Agency Office, and the Houston Minority Business Development Center hosted the event. ■

Cleveland Baker, assistant district director for minority enterprise development for the Small Business Administration's Houston District Office, presents the Minority Business Advocate Award to Debra Johnson, JSC's deputy director of procurement.

Hall earns honor for excellence in labor relations

Bob Hall, JSC's labor/employee relations officer, has been named this year's recipient of the National Labor and Employee Relations Excellence Award.

Hall, who has led the center's civil service labor relations activities since 1979, was cited for turning around the labor relations program at JSC. Before his appointment, the labor relations staff and the local union leadership spent most of their time working grievances and complaints. "It wasn't much fun and it certainly wasn't very productive," remembers Hall. The filings stopped shortly after Hall's appointment thanks to his efforts to change the fundamental relationship between management and the union, and by involving the union as partners early in important decisions. "We haven't had an arbitration case or an unfair labor practice complaint in more than twenty years, and that's pretty remarkable."

Hall gives credit to the JSC team. "Our success has really been a team effort. I'm very fortunate to be working in an environment where our Human Resources staff, the center's management team, and the union leadership all appreciate that more gets accomplished when you work together."

In addition to serving as the center's focal point for labor and employee



Bob Hall

relations activities, Hall is responsible for personnel policy development and personnel program evaluation.

JSC, its employees, and its customers have benefited from many of the programs that Hall has partnered with the union such as the development of a fully

accredited parent-operated on-site child care facility that has operated successfully for nine years; development and implementation of an array of family-friendly programs including a leave donor program, flexible work schedules, flexiplace, and part-time employment programs; implementation of a diversity council, a diversity management program, and an important and useful system of Equal Employment Opportunity metrics; improvement of JSC's occupational health and safety program which has led to certification of JSC as a VPP Star site; development of an AIDS policy that became the model for the federal government; and development and implementation of new performance management and recognition systems.

Hall has received numerous performance and special achievement awards including certificates of commendation, a NASA Exceptional Service Medal, and NASA's Equal Employment Opportunity Medal.

Hall received the National Labor and Employee Relations Excellence Award at the 10th annual Labor and Employee Relations Conference, presented by FPMI Communications, Inc., the Merit Systems Protection Board, and IHS Human Resource Products, in Orlando, Fla. ■

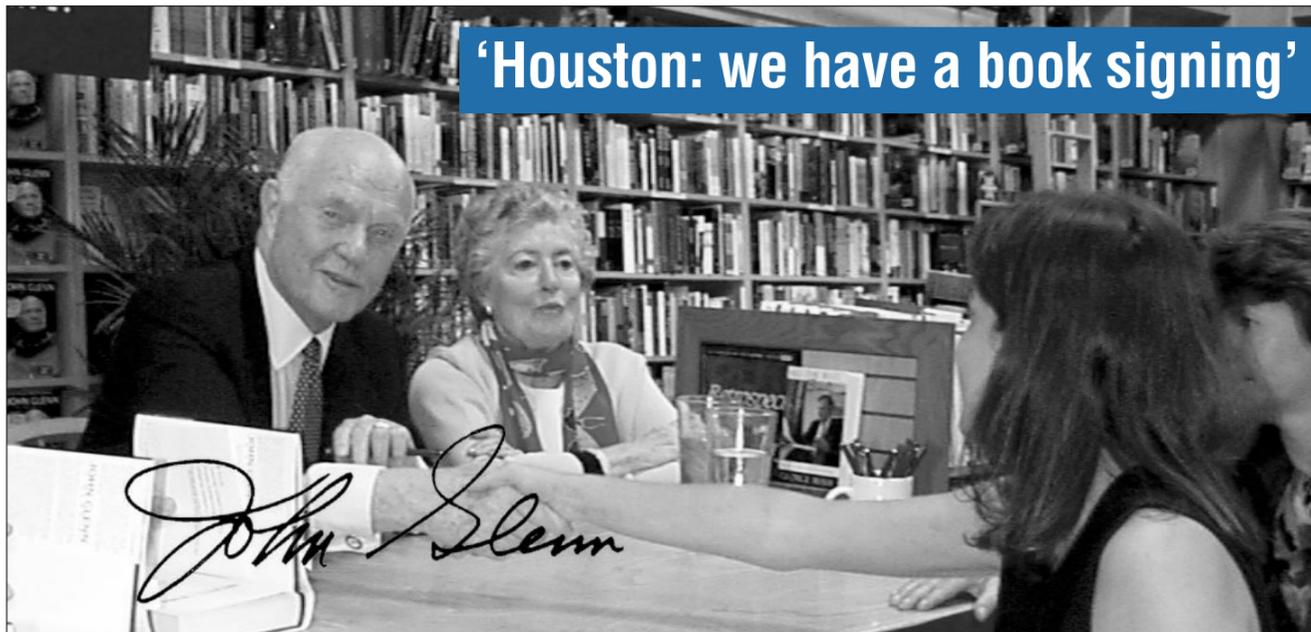
JSC retiree to receive Losey Atmospheric Sciences Award

The American Institute of Aeronautics and Astronautics recently announced that Donald J. Kessler is the 2000 recipient of the AIAA Losey Atmospheric Sciences Award. The award will be presented on January 11, 2000, during the 38th Aerospace Sciences Meeting and Exhibit at Reno, NV.

The award is presented in recognition of outstanding contributions to the atmospheric sciences as applied to the advancement of aeronautics and astronautics. Kessler will be honored "in recognition for pioneering work in the discovery and definition of the orbital debris component of the atmospheric environment."

Kessler is a retired NASA JSC senior scientist for orbital debris, and currently resides in Friendswood.

AIAA is the world's leading professional society in the broad areas of aeronautics and astronautics, and the preeminent worldwide aerospace information resource. ■

'Houston: we have a book signing'**Former Senator and Astronaut John Glenn**

recently resurfaced in Houston.

Glenn was in town for a book signing engagement at Border's Bookstore. More than 700 people lined up outside the Westheimer store for a chance to meet the man behind the legend. His book, *John Glenn: A Memoir*, was released November 2 and narrates his idyllic childhood in Ohio through his political endeavors and remarkable career in aviation and space exploration.



NASA JSC Photo S99-13845 by James Blair

The JSC Neuroscience Laboratory, from left, front: Edgar Benavides, Scott Wood, Jan Cook, Deborah Harm, Nicole Cleary, Laura Taylor; back: Millard Reschke, Troy Brown, Ajit Mulavara, Todd Schlegel, Brian Sekula, Lauren Merkle, Bill Paloski, Galen Kaufman, Jacob Bloomberg. Not pictured: Elisa Allen.

Preparing for extended space flight: *the human body's nervous system*

As lengthy stays aboard the International Space Station loom in the near future, and plans for potential missions to Mars begin to unfold, the need for a better understanding of the human body's nervous system and its reaction to the microgravity environment becomes evident.

Exposure to the sensory conditions associated with the near weightlessness environment of space rearranges the relationships among signals from visual, skin, joint, muscle, and inner ear receptors in the body. Until some level of adaptation is achieved, astronauts often experience disturbances in spatial orientation, motion control, vision, and eye-head-hand coordination. Many of these same types of neurosensory, sensorimotor, and perceptual disturbances also are observed after crewmembers return to Earth.

Placing human beings in a microgravity environment removes them from their normal living conditions. "From the moment of conception, we are 1 g organisms," said Dr. Millard Reschke, NASA's chief of neuroscience at JSC. "We're conceived, born, reared, and work in a one gravity field. If you take away that gravitational component, then there are certain specific parts of the nervous system that are going to respond."

Neurophysiological function – brain, neurology, sensory physiology, and motor coordination – is an extremely important area of investigation particularly because it cuts across so many other bodily systems that are affected by the new gravitational environment. The responsibility for overseeing this critical area is that of the scientists in the JSC Neuroscience Laboratory, whose charge is to investigate the effects of space flight on the human nervous system, with particular emphasis on neurosensory and sensorimotor changes that occur in space.

Current topics of primary concern to the researchers are balance control and locomotion, eye-head coordination, vestibulo-autonomic function, neuroplasticity and artificial gravity.

Balance Control

Upon returning to Earth, every astronaut has some degree of disrupted balance control – difficulty maintaining upright stance. After short-duration flight, this condition usually persists for two to four days. However, after extended-duration flights, the Mir space station missions for example, this condition has been seen to persist for eight to 10 days, and some subtle effects persist even longer.

Disrupted balance control hasn't been considered a significant operational problem because it resolves by itself. Moreover, whenever the crewmembers land, there is always someone there to help them get around so that they do not have to worry about losing balance and falling. But extended-duration missions to distant planets may pose significant problems.

"Our concerns have to do with how astronauts will function after a six-month mission to Mars," said Dr. Bill Paloski, senior scientist in the Neuroscience Laboratory. "Without appropriate countermeasures, the astronauts will arrive there with severely disrupted balance control, and there won't be anyone there to help them. Because of this, we're actively seeking to understand the brain's adaptive mechanisms and to develop appropriate countermeasures."

The brain uses three primary sensory organ systems to help orient the body in space: the vestibular system (inner ear), the proprioceptive (body sense) system, and the visual system. The vestibular system has two components: the semicircular canals, which are sensitive to angular movements, and the otolith organs, which are sensitive to linear accelerations and gravity.

On Earth, the brain has learned through experience to interpret information from the otolith organs as either linear motion or tilt with respect to gravity. "When you tilt your head in a gravitational field, your brain knows that you've

tilted your head due, in part, to changes in signals that the otolith organs send it," said Paloski. "When you move your head in space, there is no change in otolith signals because there is no gravity to work on that sensor. This initially confuses the brain, and can lead to some unusual perceptions, as well as to space motion sickness. Eventually the brain realizes that it should not expect those signals anymore, and so it adapts to zero gravity by relearning how to control movements without otolith tilt information."

Upon return to Earth, the otolith tilt information returns, and the brain becomes confused again, resulting in disorientation, disrupted balance control, and, in some crewmembers, motion sickness symptoms. These effects are much more profound following long-duration (Mir station) space flight than they are following short duration (space shuttle) missions.

Following long-duration flight, there seem to be some other changes that affect balance control, but that

are not related to the inner ear. These concern changes in information from the proprioceptive system.

"We have sensors all about our body [embedded within our muscles, joints, tendons, and skin] that help our brain to know what position our limbs and joints are in and what kind of pressure we're feeling when we are sitting down or standing up," said Paloski. "Information from these proprioceptive sensors is also used by the brain to maintain balance control, to keep the body upright and oriented properly."

Some of the persistent balance and coordination problems that are seen after long-duration space flight have to do with how the brain reinterprets information from these sensors. "That's something we don't really see after short-duration missions. Short-duration missions are dominated by vestibular changes – changes in the inner



John Glenn on the posture platform.

ear," said Paloski. "But we've learned from the Russians that after long-duration missions the proprioceptive changes may be more important – they take longer to appear and persist far longer afterwards."

Control of Locomotion

The ability to walk can be significantly altered after space flight. Sensory inputs including those provided by visual, vestibular, and proprioceptive sensors are required to maintain locomotor ability on Earth. Adaptation to weightlessness apparently results in changing the way the brain interprets information from these receptors. The outcome of this change is disturbances in gait when astronauts try to walk after they return to Earth.

Normal gait depends on acquiring pre-programmed patterns of muscle activation, and requires continuous monitoring of external sensory input. Detailed studies of locomotion after space flight indicate that weightlessness changes the relationship between sensory input and motor output.

One consequence of this adaptation is that orientation and movement control systems of astronauts returning from long periods in space are no longer optimized for Earth's gravity. Disturbances in postural equilibrium and gait upon return from flight have been among the most consistently reported responses associated with space flight.

Dr. Jacob Bloomberg, a senior scientist in the Neuroscience Laboratory, is investigating how space flight affects the ability of astronauts to walk after flight. "Astronauts experience significant postural and locomotive difficulties when they return after short- and long-duration space flight. This is an important operational issue because astronauts, after long-duration space flights or trips to Mars, need to be able to walk after flight. Our research involves understanding some of the underlying neurophysiological changes that are associated with these disturbances and developing countermeasures to mitigate against them."

“From the moment of conception, we are 1 g organisms. We're conceived, born, reared, and work in a one gravity field. If you take away that gravitational component, then there are certain specific parts of the nervous system that are going to respond.”

– Dr. Millard Reschke

Eye-Head Coordination

Eye movements serve two purposes: to hold gaze steady or to shift it to an object of interest. Compensatory eye movements maintain a steady image on the retina during head movements. Otherwise our vision would be blurry. The elimination of gravity alters the physiological systems – principally, vestibular and sensory motor – underlying compensatory head and eye movements.

"The changes that we see primarily pertain to the way that the eye responds when the head is moved," said Reschke. "For example, a good way to demonstrate the phenomena of compensatory eye movements is to ask the reader to shake his or her head back and forth while gazing at the printed text at about one cycle per second. Under this condition, the text will remain clear and readable because the eye, driven by the vestibular system, is moved equally and opposite that of the head – just watch someone else's eyes when they do this. If, on the other hand, you shake the paper you are reading back and forth and hold your head still, the print will be blurry because the eye and the vestibular system are not working together. We believe that in space the compensatory relationship between head and eye movements is disrupted, and that changes occur in the brain that allow adaptation to the new environment. It is during the adaptation process, whether upon the initial exposure to microgravity or the transition to a new

inertial environment [Earth or Mars], that problems will be manifest in the vestibular and visual systems.

"The real importance of the adaptive process is that compensatory eye movements, including those that move our eyes when we look at something as well as those that allow us to track a moving target,



Astronaut Ronald M. Sega (left) and Russian Cosmonaut Sergei K. Krikalev work on a joint U.S./Russian metabolic experiment (DSO 202) on the Space Shuttle *Discovery's* middeck. Note the electrodes on Krikalev's face.

are mediated by the balance organs of the inner ear where they stabilize one's vision while walking, keep an image focused on the retina when we redirect our eyes to a new target of interest, or even use our eyes

to maintain our balance."

To study compensatory eye movements, an experiment slated to be flown aboard the ISS in 2002 or 2003 will examine gaze control, and the role of prolonged space flight on the visual and vestibular systems. Pre- and post-flight studies of long duration Mir crews suggest that the changes in the brain controlling compensatory eye

movements are very long lasting. The ISS study will permit researchers to look at the adaptive process.

Vestibulo-Autonomic Function

Dr. Todd Schlegel, a research physician in the Neuroscience Laboratory, and his team are looking at relationships between changes in the inner ear and brain, and changes in the function of the cardiovascular system during and after exposure to altered gravitational environments.

"We're looking at these relationships because when astronauts return from space, they can sometimes experience, simultaneously, problems such as motion sickness, postural imbalance and orthostatic intolerance, or fainting after standing up," Schlegel said.

Historically, post-flight motion sickness and imbalance have been attributed to inner ear changes, but orthostatic intolerance has been attributed to headward fluid shifting and cardiovascular deconditioning. The work by Schlegel and his team looks at whether the inner ear changes lead to or exacerbate changes in blood pressure and heart rate upon return to Earth. The team is studying test subjects during and after parabolic flight and centrifugation.

Neuroplasticity

"The biggest problem we see is when people make transitions from one gravitational state to another," said Reschke. "It often takes weeks or months for responses to adapt."

Fortunately, the human brain is "plastic" and knows how to deal with changing

circumstances. So individuals adapt very well in transitioning from one gravitational state to another.

An approach to make the brain more "plastic" so that astronauts can more easily adapt to different gravitational states is to give it more challenges before flight – sensory incongruities that it has to sort out.

This concept got its start 15 years ago in laboratories at JSC with the development of what is called pre-flight adaptation training. Astronauts train in two part-task trainers. They are designed to simulate the same neurosensory conditions that the crewmembers will face in flight so that they can be adapted to those conditions before they fly. Repeatedly placing crewmembers in and out of altered sensory conditions gets them dual adapted, allowing the brain to develop or have two or more sets of sensory programs for different inertial environments.

"If you repeatedly put somebody in and out of these altered sensory conditions, you can get them dual adapted," said Dr. Deborah Harm, a senior scientist in the Neuroscience Laboratory. "Once dual adapted, the astronauts, upon return from space, readapt much more quickly."

Bloomberg is also developing ways to increase walking adaptability of crewmembers by using an in-flight treadmill training regimen. The ISS experiment that he is in the process of defining involves developing a countermeasure that will mitigate the effects of long-duration space flight on control of locomotion. The idea behind it is to make the astronauts more adaptable. "With

training, we hope to promote increased adaptability in walking ability so that astronauts can adapt faster when they make the transition from zero-g to Mars or Earth gravity environments."

The experiment is based on practice variability, the theory that if human beings are



Subject on treadmill

exposed to a lot of sensorimotor challenges repeatedly, they will become better learners; in essence, they will "learn to learn." The ultimate vision of this study is to create a virtual environment on a treadmill aboard the ISS. The next-generation treadmill would enable users to walk in more than one direction while immersed in a virtual environment. This would create a rich and varied walking environment that would enhance learning ability.

Artificial Gravity

In addition to making and keeping the astronauts more dual adaptive, artificial gravity may be used as a countermeasure to ease rapid transitions from one gravitational state to another.

There are two protocols to implement artificial gravity aboard spacecraft, one intermittent in which an astronaut would periodically get into an artificial gravity device and have gravity replacement therapy for the day and the other a longer arm device, a passive, permanent implementation of 1 g.

In the former, the person would go into a short-arm centrifuge and be spun around in a circle for a period of time. The brain would be triggered to remember 1 g adaptation and remember how to correlate all the different signals together with the otolith signal.

A different protocol would be to have the whole vehicle rotate. "We've talked about having two tethered vehicles, a kilometer apart, rotating slowly," said Paloski. "It would be a passive system, so you would always have this gravity load. As a result, you wouldn't have to worry about moving back and forth from zero-gravity to 1 g, which would result in some motion sickness upon each transition." Researchers are trying to understand the adaptive process so that they can develop a prescription for it – how often crewmembers would have to do this activity and for what periods of time.

There are no firm plans to have an artificial gravity device aboard the ISS, but researchers believe that having one on orbit is a good idea. "If you can keep somebody dual adapted for station and lunar/Mars missions with a centrifuge on orbit, then the recovery period and rehab that will be required upon return to Earth will be both shorter and less expensive," said Harm.

Conclusion

These countermeasures for neurological disturbances experienced during space flight are not new. A good deal of ground-based research has been done to test the theory behind pre-flight adaptation and an on-orbit centrifuge. The idea of pre-flight adaptation is now mature enough to begin evaluating its effectiveness with astronauts in the immediate future.

Future countermeasures include potential pharmaceuticals and manipulation of the basic substances of life itself. "We are looking at things at the systems level and seeing the changes there," said Reschke. "We are applying countermeasures to symptoms – that's where we've been and where we are."

Probing beyond the symptoms to the original causes of neurological disturbances experienced on orbit promises to open up new pathways and new countermeasures. ■

Ripped from the ROUNDUP

Ripped straight from the pages of old Space News Roundups, here's what happened at JSC on this date:

1 9 6 4

The Manned Spacecraft Center will soon have a flagpole.

A \$1,900 contract for an 80-foot flagpole has been awarded to the Baartol Company, Inc., of Kenton, Ohio. The flagpole will be of two-piece cone-tapered seamless aluminum construction and will be stressed to withstand hurricane-velocity winds of 100 miles per hour.

Tentative plans call for installation of the flagpole in the mall area directly in front of the center's Project Management building.

1 9 7 9

Columbia, the first space shuttle orbiter which is scheduled for flight in 1980, is undergoing its first major simulated "flight" all systems test, on or about December 15 at the Kennedy Space Center. Astronauts and ground support teams are putting the vehicle through an around-the-clock five-day critical operational trial.

Among the tests to be performed are five separate launch and ascent flight profiles, on-orbit operations, and one entry phase. Several hundred NASA and contractor engineers – at JSC, KSC, and Rockwell Downey – will take part in this Orbiter Integrated Test, one of the final verifications of Orbiter systems and electronics before the Columbia is cleared for final assembly.

1 9 8 4

Astronomers last week reported evidence of an enormous planetary object circling a star 21 light years from Earth, a finding that could represent the first observation of a planet outside our solar system.

The researchers said December 10 that this is the first claim of a planet orbiting a nearby star that is supported by direct observational evidence and not indirect measurements.

The object orbits 600 million miles from the star Van Biesbroeck 8, or VB-8, which was discovered in 1961 by astronomer George Van Biesbroeck. The star, located in the Milky Way constellation Ophiuchus, is about 21 light years, or about 126 trillion miles, from Earth. It is only about 10 percent as massive as Sol, Earth's sun, and about one third as hot.



Tips for safe and happy holidays

This holiday season; don't let the spirit of giving lull you into giving burglars, muggers, and pickpockets a better chance to do their dirty work. Crooks love the holidays as much as everyone else, but chiefly because it's an opportune time for crime. Homes jam-packed with glittering gifts, stores, malls and downtown streets teeming with unsuspecting shoppers are exactly what thieves are looking for. People rushing around, stressed out and careless, looking for last-minute gifts, trying to get everything done, make for easy crime targets. It's enough to make a crook giddy with holiday joy. Here are some tips on how to celebrate safely this holiday season.

If you're traveling:

- ❖ Get an automatic timer for your lights.
- ❖ Ask a neighbor to watch your home and park their vehicle in the driveway from time to time.
- ❖ Don't forget to have mail and newspaper delivery stopped. If it piles up, it's a sure sign you're gone.

If you're out for the evening:

- ❖ Turn on lights and a radio or TV so it looks like someone's home.
- ❖ Be extra cautious about locking doors and windows when you leave, even if it's just for a few minutes.
- ❖ Don't display gifts where they can be seen from outside.

If you're shopping:

- ❖ Stay alert and be aware of what's going on around you.
- ❖ Park in a well lit space, and be sure to lock the car, close the windows, and hide shopping bags and gifts in the trunk.
- ❖ Avoid carrying large amounts of cash; pay with a check or credit card whenever possible.
- ❖ Don't discuss high value purchases with friends in shopping malls where strangers can overhear.
- ❖ Be alert for vehicles following you home after you've made a major purchase.
- ❖ Be alert for suspicious persons and vehicles in your neighborhood.
- ❖ Deter pickpockets and purse-snatchers by not overburdening yourself with packages.
- ❖ Be extra careful with purses and wallets. Carry a purse close to your body, not dangling by the straps. Put a wallet in an inside coat or front pants pocket.
- ❖ Shopping with kids? Teach them to go to a store clerk or security guard if you get separated.
- ❖ Have your car keys in hand so you don't have to dig in a pocket or purse for them before entering your car.

If a stranger comes to the door, beware!

- ❖ Criminals sometimes pose as couriers delivering gifts.

❖ It's not uncommon for people to try to take advantage of others' generosity during the holidays by going door-to-door for charitable donations when there's no charity involved.

❖ Ask for identification, and find out how the funds will be used. If you aren't satisfied, don't give.

❖ Don't let holiday stress get the best of your holiday spirit.

❖ Make time to get together with family, friends, and neighbors.

❖ Think about reaching out in the spirit of the season and helping someone who's less fortunate or lonely.

Do your part to make the holidays a safe and happy time for everybody – except criminals.

Take a holiday inventory:

The holidays are a good time to update – or create – a home inventory list. Take photos or make videos of items, and list descriptions and serial numbers. If your home is burglarized, having a detailed inventory can help identify stolen items and make insurance claims easier to file. Make sure things like TVs, VCRs, stereo equipment, cameras, camcorders, sports equipment, jewelry, silver, computers, home office equipment, and power tools are on the list. Remember to check it twice. ■

GILRUTH CENTER NEWS

Open from 6:30 a.m.-10 p.m. Monday-Thursday, 6:30 a.m.-9 p.m. Friday, and 9 a.m.-2 p.m. Saturday. Contact the Gilruth Center at (281) 483-3345.
<http://www4.jsc.nasa.gov/ah/exc/aa/Gilruth/Gilruth.htm>

Nutrition intervention program: Six-week program includes lectures, a private consultation with the dietitian and blood analysis to chart your progress. Program is open to all employees, contractors and spouses. For details call Tammie Shaw at x32980.

Defensive driving: One-day course is offered once a month at the Gilruth Center. Pre-registration required. Cost is \$25. Call for next available class.

Stamp club: Meets every second and fourth Monday at 7 p.m. in Rm. 216.

Weight safety: Required course for employees wishing to use the Gilruth weight room. Pre-registration is required. Cost is \$5. Annual weight room use fee is \$90. The cost for additional family members is \$50.

Exercise: Low-impact class meets from 5:15-6:15 p.m. Mondays and Wednesdays. Cost is \$24 for eight weeks.

Step/bench aerobics: Low-impact cardiovascular workout. Classes meet from 5:15-6:15 p.m. Tuesdays and Thursdays. Cost is \$32 for eight weeks. Kristen Taragzewski, instructor.

Yoga: Stretching class of low-impact exercises designed for people of all ages and abilities in a Westernized format. Meets Thursdays 5-6 p.m. Cost is \$32 for eight weeks. Call Darrell Matula, instructor, at x38520 for more information.

Ballroom dancing: Classes meet Thursdays from 6:30-7:30 p.m. for beginner, 8:30-9:30 p.m. for intermediate and 7:30-8:30 p.m. for advanced. Cost is \$60 per couple.

Country and western dancing: Beginner class meets 7-8:30 p.m. Monday. Advanced class (must know basic steps to all dances) meets 8:30-10 p.m. Monday. Cost is \$20 per couple.

Fitness program: Health-related fitness program includes a medical screening examination and a 12-week individually prescribed exercise program. For details call Larry Wier at x30301.

Aikido: Martial arts class for men and women meets 5-6 p.m. Tuesdays and Wednesdays. No special equipment or knowledge is needed to participate. Aikido teaches balance and control to defend against an opponent without using strength or force. Beginning and advanced classes start each month. Cost is \$35 per month.

TICKET WINDOW

The following discount tickets are available at the Exchange Stores

General Cinema Theaters	.....	\$5.50
Sony Loew's Theaters	.....	\$5.00
AMC Theaters	.....	\$4.75
Moody Gardens (2 of 6 events) (does not include Aquarium Pyramid)	....	\$10.75
Moody Gardens (Aquarium only)	.....	\$9.25
Space Center Houston	..... adult	\$10.25
	..... child (age 4-11)	\$6.50
	(JSC civil service employees free.)	
Space Center Houston annual pass	.....	\$18.75
Entertainment Books	.....	\$20.00
Clear Lake Coupon Books	.....	\$30.00
Sweet Water pecans for holiday baking	.....	\$6.00

Please bring your driver's license to pay by personal check.

Exchange Store hours

Monday-Friday
 Bldg. 3 7 a.m.-4 p.m.
 Bldg. 11 9 a.m.-3 p.m.

- All tickets are nonrefundable.
- Metro tokens and value cards are available.
- Franklin Planners now available.

For additional information, please call x35350.

On being Santa – the gift that gives back

By Mary Peterson

With a nickname like “Bear” and the dimensions to go with it, you might reasonably expect that notice of an impending safety inspection by Muñiz Engineering’s Ed Handwerk could send workers into a frenzy of clean up, spruce up, fix up, before the great one came thundering through. That has been known to happen, at least once, when a worker, new to the Sonny Carter Training Facility, warned his buddies in a panic, “We’re havin’ a safety inspection, and they’re sending this big guy, and he’s called a “bear!”

In truth, Bear Handwerk, is really more the jolly sweet elf of his Christmas-time persona, Santa Claus, than the awesome bruin his nickname suggests. And a convincing Santa he is. Naturally endowed with a baritone ho-ho-ho and an easy presence with children, he dons his red velvet, fur-trimmed suit, topping it off with a realistic, curly white beard, and the transformation is complete.

It was enough to convince Olivia Harris, 6, granddaughter of Muñiz’s Howard Sloan. She got an early audience with Santa and Mrs. Claus when she shared a photo session recently at JSC and received some early presents. So convinced was the young girl that she gave Santa a bit of her own advice: “Remember, it will be cold when you leave [the North Pole], so you’d better put on a sweater before you get in the sleigh!”

Still another time, Handwerk, dressed in jeans and red suspenders, had settled into a backroom station at a Friendswood styling salon to get his newly purchased wig and beard trimmed to a more suitable length. Although the door was shut, it wasn’t enough to keep out the curious, prying eyes



NASA JSC Photo 14795 by Bill Stafford

Georgia and Ed Handwerk transformed to Mrs. and Mr. Santa Claus share the the holiday spirit with Olivia Harris.

of a small girl, bored with waiting for her mother. “Merry Christmas!” smiled Handwerk. Recognition was immediate, and the young girl ran to the forward part of the salon, shouting for all to hear, “Mama, Mama! Santa Claus is back there, and he’s getting a haircut!”

This marks the fifth year Handwerk has played Santa, which he does as a community service, and the fourth year

he has worked with the Friendswood Fire Dept. on its annual Santa Rides, where fire trucks are paraded through neighboring streets and candies are dispensed to the children. For the past two years, wife, Georgia, a recreational therapist, has joined in as Mrs. Claus.

Why a Santa? “I enjoy being Santa,” Handwerk says, “because the kids enjoy it so much. I get back much more than I

give.” And, it’s not just the kids. He gets parents and other adults into the spirit.

Lest you think being Santa is a piece of cake, consider. Although usually excited, kids are sometimes overwhelmed, sometimes scared, and sometimes these emotions are manifest in a warm, wet feeling on Santa’s leg. This results in a swift, lateral pass to mama that would make Troy Aikman proud.

Then, of course, there are those who want to put Santa on the spot. “You should know what I want. What are YOU going to bring me?!” This calls for some fast eye-hand-lip coordination in the direction of the parents for some clues.

Proof that Santa appeals to all ages, Handwerk often has band students who want a picture with Santa, or he’ll kibitz with the local police who help with the parade. And, groan, there are even a few, long since past hugging-size, who want to sit on Santa’s knee.

The Bear has developed his own philosophy of giving. “I think of Santa, not as a religious tie-in, but as the universal ambassador of love and goodwill, and this is what I try to impart to the children. I do, after all, get children of all faiths – Judaism, Muslim, Hindu, and others.” Never far removed from his work as a senior safety engineer, he also reminds tots to stay clear of lighted candles, fireplaces, and other hazards associated with the season.

One of Handwerk’s more touching missions is paying visits to the elderly and infirm. “We have a number of assisted living homes in Friendswood,” said Handwerk, “and nurses will help wheel out the disabled to see Santa. Often this includes handicapped children. It’s the highlight of their season. Mine, too.” ■

JSC employee shares the spirit of giving throughout the year

It’s the holiday season again, where countless greeting cards wax the warmth of the season and that familiar ringing outside of the local retail stores remind us to give to those less fortunate.

But all around us are people who give of themselves every day – the story of JSC’s Ernie Romero is one such example.

Two years ago, *Space Center Roundup* first reported when Romero and his wife, Cheryl, adopted four sibling children to join their first two.

Since then, the Romeros have united as a family and, in fact, were recently recognized as Family of the Year by the Texas Department of Protective and Regulatory Services. But the story doesn’t stop there. If you take a quick glance at all that this man does, you’ll see the true meaning of giving.

Any parent will tell you, (and some childless people too!) – children are a lot of work and bringing them up right is an unguaranteed challenge, even for the most diligent of parents. Try raising six, compounded with the emotional weight that comes with adopting. Courageous is a word that comes to mind.

Anyone who has met the Romeros will tell you they’re doing a great job with their family. “They are both just really neat people,” said Diane Scruggs, the Romeros’ caseworker. She couldn’t say enough good things about how nurturing the Romeros are and how well disciplined the children are with them. “I have really bonded with Ernie and Cheryl through this process and just to walk into their home, you can see how close they’ve become as a family and how much the kids respect them.”

Ernie Romero says his emphasis on academics has really pulled the family together. “My wife and I are both pursuing computer science degrees, so the kids see us studying at night and working on assignments,” said



ALL IN THE FAMILY: The Romeros were named Family of the Year by the Texas Department of Protective and Regulatory Services. Left to right, Victoria, 8, Ernie, Carlos, 5, Alex, 7, Sarita, 13, Anna, 10, Cheryl, and Ernie Jr., 10.

The Romero family would like to extend a special thank you to Sue Garman, Kaz Hall-Farley and the Executive Board of the American Federal Government Employees Union for their support.

Romero. “And a lot of times, we all go to the library together, so they see that the work it takes to achieve your goals in life.”

The Romero children aren’t missing a beat. Ernie Jr., Anna and Victoria were recently selected to represent their district in academic competitions, and Romero says all the children are bringing home good grades. “My biggest goal for them is to get a solid education,” said Romero.

Romero is heavily involved in activities for other foster children, whether its bringing NASA and crew paraphernalia

to gatherings to excite them and help reinforce the education message or rounding up the Houston Fire Department or D.A.R.E. representatives to participate in special events. “I can’t bring enough NASA stuff. I always run out,” he said.

Romero, a mechanical engineer in the manufacturing and production branch, started as a machinist at JSC more than eight years ago. “I grew up in Los Angeles and I know how important it is to have someone to mentor you, to be a role model,” said Romero. “That is why I try so hard with

these kids. It was scary at times, to think of taking on four more children, but we knew we could not let them down. We couldn’t bare the thought of them getting separated.”

Romero’s philosophy is extended to other children in the community and to co-ops as well. He frequently welcomes co-ops and recent grads to his home for family functions and holiday dinners to give them a “home-away-from-home.”

“He was quick to open up his home to me,” said Ebonika Williams, who co-oped in Romero’s division last fall. “He and his wife are great and they have one of the most loving families I’ve ever met. I always feel welcome and he’s always been there to listen to me. He’s very positive and pushes me to do well.”

Aside from being the father of six and a college student on the side, Romero runs a side business called Jump-a-thon which rents “moon walks” for special events and charitable causes. He also volunteers extra time with CPS as a mentor for other adoptive and foster parents.

“He is always there to help,” said Scruggs. “Even on short notice, I can call him and without hesitation, he is willing to help. He and his wife are really a team – they’re one of a kind.”

For Romero, this is just his way of giving back. “During the process leading up to the adoption, there were a couple times I caught myself thinking, ‘Oh – can I really do this?’ But at those same times, I would always see a sign to keep me going, pushing me to save these four lives.”

In his mind, the children went through so much before reaching him, that they’re heroes to him, but the kids feel the same way. “They tell me, ‘Dad, we know you’re not an astronaut but you’re still our hero.’”

So remember this holiday season – love is the best gift of all. ■

DATES & DATA

December 22

Astronomy seminar: The JSC Astronomy Seminar Club will meet at noon Dec. 22, 29 and Jan. 5 and 12 in Bldg. 31, Rm. 248A. For more information, call Al Jackson at x35037.

Spaceland Toastmasters meet: The Spaceland Toastmasters will meet at 7 a.m. Dec. 22, 29 and Jan. 5 and 12 at the House of Prayer Lutheran Church. For more information, call George Salazar at x30162.

Spaceteam Toastmasters meet: The Spaceteam Toastmasters will meet at 11:30 a.m. Dec. 22, 29 and Jan. 5 and 12 at United Space Alliance, 600 Gemini. For more information, call Patricia Blackwell at (281) 280-6863.

December 23

Communicators meet: The Clear Lake Communicators, a Toastmasters club, will meet at 11:30 a.m. Dec. 23, 30 and Jan. 6 and 13 at Freeman Library, 16602 Diana Lane. For more information, call Allen Prescott at (281) 282-3281 or Mark Caronna at (281) 282-4306.

January 6

Warning System Test: The site-wide Employee Warning System will perform its monthly audio test at noon Jan. 6. For more information, call Bob Gaffney at x34249.

January 9

National Space Society meets: The "Westside" group of the Clear Lake area chapter of the National Space Society will meet at 2 p.m. Jan. 9 at Silicon Graphics, 11490 Westheimer, Suite 100. For details, call Murray Clark at (281) 367-2227.

January 11

Aero Club meets: The Bay Area Aero Club will meet at 7 p.m. Jan. 11 at the Houston Gulf Airport clubhouse at 2750 FM 1266 in League City. For more information call Larry Hendrickson at x32050.

National Space Society meets: The Clear Lake area chapter of the National Space Society will meet at 6:30 p.m. Jan. 11 at the Freeman Memorial Branch Library, 16602 Diana Lane. For more information call Murray Clark at (281) 367-2227.

NPMA meets: The National Property Management Association will meet at 5 p.m. Jan. 11 at Robinette and Doyle Caterers, 216 Kirby in Seabrook. Dinner costs \$14. For more information call Sina Hawsey at x36582.

January 12

IAAP meets: The Clear Lake/NASA Chapter of the International Association of Administrative Professionals (formerly

Professional Secretaries International) will meet at 5:30 p.m. Jan. 12 at Bay Oaks Country Club. Cost is \$16. For details and reservations, call Tami Barbour at (281) 488-0055, x238.

January 13

Airplane club meets: The Radio Control Airplane Club will meet at 7 p.m. Jan. 13 at the Clear Lake Park building. For more information call Bill Langdoc at x35970.

MAES meets: The Society of Mexican-American Engineers and Scientists will meet at 11:30 a.m. Jan. 13 in Bldg. 16, Rm. 111. For more information, call George Salazar at x30162.

January 14

Astronomers meet: The JSC Astronomical Society will meet at 7:30 p.m. Jan. 14 at the Center for Advanced Space Studies, 3600 Bay Area Blvd. For details, call Chuck Shaw at x35416.

January 19

Scuba club meets: The Lunarfans will meet at 7:30 p.m. Jan. 19. For more information, call Mike Manering at x32618.

January 20

Directors meet: The Space Family Education board of directors will meet at 11:30 a.m. Jan. 20 in Bldg. 45, Rm. 712D. For details on this open meeting contact Lynn Buquo at x34716.

January 22

Volunteers sought: AIAA seeks volunteers to assist with "Physics is Fun" event January 22 from 9 a.m. to noon in Gilruth gym. Volunteers can bring their own demonstrations or use established demonstrations to share with the more than 100 anticipated middle school students. For more information contact Joy Conrad at jconrad@averstar.com.

January 24

Alzheimer's support group meets: The Clear Lake Alzheimer's Caregiver Support Group will meet at 7:30 p.m. to 9 p.m. January 24 in the first floor conference room, St. John Hospital West building, Nassau Bay. For details, contact Nancy Malley at (281) 480-8917 or John Gouveia (281) 280-8517.

January 27

Radio Club meets: The JSC Amateur Radio Club will meet at 6:30 p.m. January 27 at the Piccadilly, 2465 Bay Area Blvd. For more information, call Larry Dietrich at x39198.

February 21 - 25

Engineers Week: For volunteer opportunities see <http://www4.jsc.nasa.gov/scripts/eweek/>

Payload Safety Conference

The Nassau Bay Hilton, Houston, Texas, will be the site of a Payload Safety Conference on February 23-25, 2000. The conference theme is "Mission Success Starts with Safety."

The objectives of the conference are to provide payload organizations with a common, accurate understanding of payload safety technical and process requirements, to foster synergy within the payload safety community, and to promote payload safety as the foundation for mission success. The conference is primarily intended for personnel responsible for the design and safety certification of International Space Station and shuttle payloads, including payload safety engineers, project managers, and technical support specialists.

General sessions will include presentations on payload safety challenges in the ISS era, the payload safety Data Management System, and process and technical requirements for both ground and space flight safety. More specialized sessions will be offered on technical topics, including pressure systems and pressure vessels, batteries, materials, structures, fracture control, fire detection and suppression, extravehicular activity, toxicology, electrical power distribution, and bonding and grounding.

Dr. Bonnie Dunbar will address attendees at the conference luncheon on February 24.

The conference Web site is located at www.rsis.com/nasa/conference/introl/

If you have any questions, contact Michael Ciancone at 281-483-8848 or e-mail at mciancon@ems.jsc.nasa.gov.

Roundup takes holiday break until January 14

This issue of *Space Center Roundup* will be the last of 1999. The next scheduled date of publication would have been December 31. The first Roundup of 2000 will be published on January 14. The *Roundup* editors wish everyone a safe and happy holiday season and a great 2000. ■

NASA BRIEFS

NEW TECHNOLOGY WILL INCREASE ON-TIME LANDINGS

Help may soon be on the way to air travelers frustrated with ever-increasing delays at the nation's airports.

NASA, Honeywell Technology Center and Honeywell Airport Systems have developed new technology that could solve a significant part of the problem. Called Airborne Information for Lateral Spacing (AILS) and Closely Spaced Parallel Approaches (CASPER), the systems expand on existing communication and navigation technology to allow planes to land safely in bad weather on parallel runways spaced as closely as 2,500 feet apart.

Currently, the minimum runway separation during low visibility is 4,300 feet, which means that some of the nation's busiest airports have to shut down one of their closely spaced runways when weather conditions deteriorate. Some of the airports where this new technology could improve on-time arrivals are Detroit, Seattle, Minneapolis and Memphis.

GAMMA-RAY BURSTS LIGHT WAY TO EARLY UNIVERSE

NASA astronomers say they have uncovered a specific property of gamma-ray bursts that will enable them to gauge the distances to thousands of these powerful explosions, many perhaps beyond the reach of all existing telescopes.

This finding, experts say, may allow scientists to determine the geometry of the universe throughout its various epochs, as well as when and where massive stars formed in the very early universe.

A team led by Dr. Jay Norris, an astrophysicist at NASA's Goddard Space Flight Center, performed the new analysis using data from NASA's Compton Gamma Ray Observatory and several optical telescopes.

"If our finding holds up, this could be a new window on the distant universe," said Norris.

Gamma-ray bursts occur randomly several times a day without warning, typically last only a few seconds to a minute, and apparently release more energy than any explosions in the universe other than the Big Bang itself.

ASTRONOMERS DISCOVER NEW PLANETS

A team of astronomers searching the galaxy with powerful telescopic instruments has found six new planets orbiting nearby stars, increasing the number of planets astronomers have discovered outside our solar system by more than 25 percent. This brings the total number of known planets outside the solar system to 28, all of which have been found within the last five years.

The astronomers made the discoveries as part of a long-term project supported by the National Science Foundation and NASA to survey 500 nearby stars for orbiting planets. Steven Vogt, University of California, Santa Cruz; Geoffrey Marcy, University of California, Berkeley; and Paul Butler, Carnegie Institution, along with Kevin Apps, a student at the University of Sussex, England, used the Keck I telescope in Hawaii, outfitted with the "HIRES" spectrometer. They will report their findings in the *Astrophysical Journal*.

SPACE CENTER Roundup

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EditorWilliam Jeffswilliam.p.jeffs@jsc.nasa.gov
 Assistant EditorNicole Cloutierncloutie@ems.jsc.nasa.gov

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